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ABSTRACT

This document is an abbreviated version of the report "An Assessment of Factors Which Influence Minority Participation in the Sciences." The report aims to present: (1) a critical analysis of the sources and availability of educational opportunities for minorities to learn about science careers, and (2) recommendations for interventions targeted at influencing the choices of minority students with respect to science careers. The intervention principles included in this document are designed to aid statewide secondary educational systems, colleges and science industries in altering the present pattern of low minority participation in non-traditional career fields--especially in the fields of science and engineering. (Author/RH)

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Factors Affecting Minority Participation in The Sciences
Summary, Conclusions and Recommendations

1977

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FOREWORD

This document is an abbreviated version of the report *An Assessment of Factors Which Influence Minority Participation in the Sciences*, and was prepared under contract for the National Science Foundation. The report aims to present (1) a critical analysis of the sources and availability of educational opportunities for minority students to learn about science careers, and (2) recommendations for interventions targeted at influencing the choices of minority students with respect to science careers.

The intervention principles included in this document are designed to aid statewide secondary educational systems, colleges and science industries in altering the present pattern of low minority participation in non-traditional career fields—especially in the fields of science and engineering.

PREFACE

The low participation of blacks in the scientific and technical job markets is clear. Although blacks represent 11.5% of the total population (1975), less than 1% of all engineers are black. Current statistics also indicate that among the approximately 287,000 Ph.D's in the national labor force, there are approximately only 4,000 black Americans with Ph.D's. There is only one black physician for every 6,000 blacks, as contrasted with one white physician for every 640 of the population. While, white scientists and engineers represent 16% of the total number of white professional and technical workers, black scientists and engineers represent 1.6% of the total number of black professional and technical workers.

Although the need for manpower is increasing, fewer black students are majoring in and achieving degrees in science and mathematics. The number of black high school graduates with prerequisities to enter college as science and mathematics majors is decreasing more rapidly than the national average. Simultaneously, school systems are decreasing their number of required courses in science and mathematics for graduation.

The low participation of blacks in the professional and technical job markets, coupled with the declining number of black students enrolling in science and mathematics and the projected growth in employment opportunities in these fields by 1980, suggests that a major national effort is needed to increase and redirect the flow of blacks into these areas.

This survey was designed to identify and assess those factors which impact the decisions of black students regarding the pursuit of careers in science and mathematics. The specific objectives of the study were threefold: (1) to determine current practices in high schools, colleges and science-related industries which affect career choices; (2) to determine the attitudes of high school seniors and college freshmen toward science as an activity and scientists as career models; and (3) to determine other intervening factors (e.g., student perception of his ability to control his environment) which may affect a student's choice of a science career.

The study sampled 200 high school students, 138 college freshmen, 30 high school counselors, 37 high school teachers, and 15 science employers located in a target area of four consanguineous cities in a southern state. The four cities made up a major metropolitan area, which, prior to school desegregation, had a strong history of segregated public schools. This area also had a historically black college, which had traditionally serviced the black education needs of the area.

The four cities and their respective school districts represented the broadest number of students attending the college. More than 60 percent of the college's student body were graduates of the 21 feeder high schools in the four school districts. In addition to the suitability of the public schools and the college, the area contained a manufacturing complex, a military base, a government research center, as well as numerous health facilities and engineering, chemical and communication-type operations normally found in metropolitan areas.

The summary, conclusions and recommendations presented in this report primarily derived through the use of seven questionnaires and interview schedules specifically developed for the study. All instruments were rigorously tested before inclusion in the study.

Because of the diversity of the measures taken, several non-parametric and parametric statistical techniques were used. For example, descriptive statistics were used to display data which indicated trends within the responses of various samples. The Pearson Product-Moment Correlation was used to analyze pairs of data for which correlational relationship were desirable. The student t-test was used to measure differences between the responses of science and non-science students, male and female students, and students attending predominantly black and non-predominantly black high schools. Chi-square was used to show comparisons between proportions and within tables of frequency counts. The .05 level of confidence was established as an acceptable significance level.

The study was completed under the joint sponsorship of the Institute for Services to Education, a nonprofit research and development corporation, and Norfolk State College. An advisory committee, composed of nine persons working and living in the

target area, was organized to work with the principal investigator in the execution of the study. Committee members were college and high school science teachers, counselors and administrators who had worked closely with the communities and were knowledgeable of the potential problems which were to be encountered during the course of the study.

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SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study sought to answer fundamental questions related to (1) the availability of educational opportunities for minority students to learn about science careers; and (2) intervening factors which influence student career choices. With regard to these issues, the findings identified shortcomings in the system from which the pool of future black scientists and engineers is to emerge. The findings also implied changes which need to be made in achieving parity for blacks in the sciences and science-related occupational fields.

Availability of Science Career Information

Although counselors and teachers showed general awareness of expanding career opportunities for minorities in the sciences, their awareness was primarily based on the knowledge of affirmative action programs and recognition of a growing global awareness that the sciences, like many other employment areas in which blacks are underrepresented, are making attempts at correcting these deficits.

School personnel felt most knowledgeable and most capable of apprising students of career opportunities in the health care fields. Ironically, engineering and sciences other than health and health-related fields are the ones which show the most glaring absence of minorities and, consequently, are the ones in which the greatest motivating and recruiting efforts should be made. Yet, counselors and teachers also felt that their general knowledge of career patterns in the sciences was lacking, especially since this is an ever changing area in which new jobs and emphases are opening up constantly. Consequently, they were severely limited in the type and amount of information they could pass on to students generally and minority students specifically. It is recommended:

- That counselors and teachers be apprised of career opportunities for minorities in the sciences. Corporations, foundations, and other organizations which recognize the disparity regarding blacks in the scientific fields should stimulate redress in this area by funding or initiating activities (e.g., newsletters, workshops, regional conferences) designed to keep science teachers and counselors abreast

of the reward for blacks in the scientific fields, as well as occupational directions in such fields.

The main thrust of all existing science awareness programs, excluding cursory activities such as displays and field trips, seemed geared toward college students rather than high school students. For examle, most science-related businesses and agencies which participated in the study were involved in some form of student-science awareness programs with the local participating college. Presentations to students and school personnel and the distribution of literature to the schools represented the main thrust of such efforts. In more in-depth efforts, many of the industries had been involved in some form of work-study or cooperative educational arrangements with college students, and a few had sponsored internship programs for high school students.

The small, local firms in the area, however, were doing little, if anything, to enhance science awareness among high school students; thus supporting the claims of high school personnel that little interaction existed between the science industry and the public schools. Employer involvement in school career education was rated as slight to nonexistent by the majority of teachers and counselors. What limited cooperation existed between employers and the public schools was generally initiated by the schools themselves. For the minority student, the most hoped for and immediate outcome seemed to be recruitment. Since few companies recruited at the high school level and only then for low-level, non-scientific positions, the most lucrative period for attracting students into scientific fields was left untapped. Where efforts were made to tap the high school years, only a small group of students highly interested in the sciences were made privy to such efforts.

A similar pattern is evident at the college level where the major emphasis on career information occurs in the form of recruitment drives and counseling sessions during the final years of college. The freshman college student, like the high school senior, is left to fulfill the necessary graduation requirements through course work, without any major emphasis on career opportunities. It is recommended:

- That coordinated efforts be made to expose counselors teachers and students to the full range of careers which exist in science. Efforts on the part of science industries, local colleges and professional schools appear spotty at best and are often self-serving. Influential organizations such as the National Academy of Sciences and the National Science Foundation, should encourage and facilitate coordination of these efforts on a regular basis so that the full complement of science-related occupations is represented through a combination of contributions from science industries, colleges and professional schools, state agencies, and the school science curriculum.

For the high school and college student, the majority of information received about science careers appeared to come from the instructor and/or from the content courses. Although this may be enough for the student whose exposure to science career information extends beyond this restricted sphere, it is not enough to attract large numbers of minority students into science and science-related fields. By far, the largest group of students are lost to potential careers in science at the end of their sophomore year in high school, when mandatory science requirements are satisfied. Without further encouragement at this point, students do not continue to more advanced level science courses, but begin looking toward other potential careers. It is recommended:

- That organized efforts addressed to career education begin prior to entry into high school and continue throughout the high school experience. Such education should parallel course selection, in order to insure that students are continuously apprised of the career options implicit in specific courses. Simultaneously, students should be apprised of the career options they impose upon themselves, through failure to pursue specific courses. In this way, a student's high school or college work becomes a stepping stone to an ultimate career plan.
- That science teachers play a major role in the curriculum development and counseling processes. Since teachers tend to impact students' interest in science more than any other variable, their ideas and recommendations should be

of major importance. In further support of this, teachers are in a better position to evaluate the learning needs and progress of minority students.

The Career Selection Process

The data suggested that by the senior year of high school, students had begun to focus on specific careers. Career selection seemed dominated not as much by the advisement of the high school counselor as by the student's preference in light of what he felt he could do best and what field offered him the most gratification in the way of service, prestige and monetary reward. Careers selected at this early state tended to be those options which the student perceived as most visible and popular in his immediate environment (e.g., teaching, community service work, business). Courses which tended to be irrelevant to these careers appeared to be low-interest courses. Science courses appeared to fall into this category. It is recommended:

- That interventions be introduced to bring science careers within the purview of minority students. Practicing scientists and engineers must be drawn into the community. Science employers must make efforts to employ minority students in capacities which allow them to observe scientists first-hand. Counselors, science educators, curriculum specialists, community workers, and science industries must work closely to supply appropriate role models for students to emulate.

  Moreover, students must be exposed to the full array of persons employed in science and engineering (e.g., the chemist working in the laboratory, the civil engineer working on the construction site, the environmental scientist seeking to reconcile environmental proglems with people problems). A national, state or local program in which scientists in conjunction with community leaders work toward solving community problems would help in enhancing the visibility and service orientation of science.

Generally, students tended to take science to satisfy requirements for high school graduation and for entry into college. Rarely were science courses viewed as pathways to profitable and successful careers. Such courses tended to be perceived as dilletante exercises—something to know. Frequently, students ap-

peared to be incapable of recognizing the practical utilization of science courses as a bases for careers or earning a living. In this sense, it appeared that the schools and science industries had failed the student.

Unfortunately, for the freshman college science major as well as the pre-college student, science career information is still not forthcoming in sufficient quantity to open up non-traditional career paths in the sciences. The number of proclaimed science majors looking toward careers in teaching and other areas attests to the limited vistas inherent in career choice. Also, the number of students seeking careers in the more traditional health and allied health fields versus those looking toward the less traditional physical sciences and engineering areas suggests that students are being programmed to follow well-established career modes. It is recommended:

- That colleges begin programs for systematically enlarging the scope of science careers pursued by their graduates. Counseling and career information should be given throughout the college experience.

- Consortia composed of colleges, universities, and science industries should be organized to serve as a base for coordinating and channeling science career information to students. This service should include dissemination efforts related to graduate school options, especially the extent of career and preparational opportunities available to students beyond the training emphasis of their particular institution.

Counseling Practices

The counseling practices of white counselors tended to differ somewhat from those of black counselors, regarding minority students. In the integrated school settings investigated, the counseling practices used to encourage minority students to explore science careers differed little from those used for other students. Counselors indicated that where interest was shown, they generally did everything possible to encourage students to pursue science careers. Generally, the counselors felt that minority students were recommended to follow science careers as often as white students. However, they readily admitted that a dispro-

portionately small number of minority students take advanced science courses.

White counselors tended to feel that targeted counseling perpetrated a disservice to all students. If anything, white counselors, through benign neglect, permitted students to follow short-term goals, often ending in low paying, dead-end jobs. Moreover, white counselors who did not view the sciences as obvious fields of endeavor for minority students consciously or subconsciously reinforced this feeling. Consequently, science career information that was accessible was not passed on to minority students, or the information communicated was relegated meaningless by the negative context in which it was presented.

Black counselors felt that alternative counseling practices were necessary to adequately motivate minority students. For example, black counselors urged students to enroll in academic courses. They believed that in the absence of strong home influences, the educational system must work as a surrogate parent, influencing students to prepare for college and success in a variety of fields through specific course work.

In summary, the study revealed that counseling procedures tended to be imbued with contradiction. On one level, counseling procedures were geared toward giving every student the same opportunity; on another, such procedures systematicaly excluded certain students by denying them needed services and motivation. Counseling practices thus appeared to give credence to benign neglect of all but a few students who fitted a classic mold. The mold in this case applied to minority students with good grades in academic subjects and who were sufficiently motivated to seek science career information. Counseling efforts were targeted on these students. Students who deviated from this mold were directed toward other or less challenging fields of endeavor.

Ironically, when seeking career information, students who had a strong interest in the sciences tended to rely more on parental advice and reading material than the advisement of counselors. On the other hand, the less motivated students tended to seek out a career on their own, relying on peer influence or influences external to the school environment (i.e., "personal reasons"). For both groups, the strongest school-related influence was the teacher, not the counselor.

These facts tended to support the counselors' statements that most students have made fairly firm career decisions by the time they reach the counselor. The counselor's role at that point became one of channeling the student along a predetermined path. This happens only if the minority student is interested in pursuing a science career.

These practices were substantiated by black counselors, who felt that minority students were not recommended as frequently as other students to take advanced science courses or to investigate science careers. Moreover, they felt that when minority students showed an interest in a science career and sought career information along these lines, their backgrounds in science and mathematics courses were not as strong as those of white students. Thus, it was unlikely that minority students would find encouragement to prepare themselves for science careers under the present system.

Present counseling practices are not structured to pull minority students out of the present cycle of career patterns and into less traditional career paths. Rather, they merely serve to reinforce old established patterns. Unless the student finds the impetus for breaking the cycle himself or is encouraged by the high school teacher, he will not go on to seek careers in the sciences.

Greater efforts are needed for school systems to come to grips with the realities of career counseling for minorities. Counselors must first be made aware of the real-world job opportunities for minorities. Secondly, counseling approaches must be altered to accommodate and channel the low interest student and open up vistas of available career options to students whose background and cultural milieus have been severely limited. Thirdly, vocational counseling seems to be geared toward the non-college prone student. Vocational counseling must be provided for the college-going student as well. It is recommended:

- That channeling minorities into the sciences and other fields which are in need of qualified minorities become a priority of secondary school counselors. This means that secondary school counselors must keep abreast of current and future directions for minorities in the scientific field as well as expanding opportunities. A redefinition of vocational counseling, to include career counseling for students continuing their education is also in order.

- That school systems institute training sessions for counselors whereby they are sensitized to the specialized needs of minority students. These sessions should be designed and directed by minorities and exploit the counseling methods and experiences of minority teachers.

- That computerized course selection whereby counselors are often excluded from the process of course selection should be minimized. *Counselors should be given greater responsibility for counseling.* Further, counselors should be urged to encourage minority students to take a full complement of academic courses, thereby enhancing their options for entry into college and success therein.

- That additional research should be undertaken to investigate the type and quality of counseling services for minority students in integrated schools. Research efforts should also be initiated to examine the short- and long-range effects of counseling services in integrated secondary schools and colleges on the career choices of minority students.

- That only counselors who show an earnest interest in the welfare of minority students should be permitted to interact in counseling situations with minorities. This would protect minority students from counseling practices which tend to dissuade minorities from entering technical and professional fields.

Counselor/Teacher/Student Interaction

The achievement of parity for blacks in the technical and professional job markets will require the joint efforts of counselors, teachers and students. The results of the survey indicate that the interaction between counselors, teachers and students tended to be unilateral at best.

Students generally credited the high school teacher as having the most influence on career choices. Inherent in this conclusion is the fact that students tend to continue in courses of interest which promise personal benefits (e.g., high grades and a base for some future vocation). Of course, the instructional practices of the teacher ultimately determine the degree of influence he/she has on the career choices of students.

Students rank the counselor as the second person they would seek out for specific career information. Consequently, the teachers and counselors collectively exert considerable influence on the career-related decisions of students.

The data on teachers' perceptions of counseling practices reflected the frequency of interaction between students and teachers relative to career goals. Despite the potentially strong role teachers can play in the counseling process, they often feel unqualified or lack the time for in-depth discussions. On the other hand, teachers often feel excluded from the process and desire greater interaction with counselors regarding student needs.

Counselors did not appear to be adequately utilizing teachers as resources; neither did the organization of schools provide teachers with the time and resources for involvement in counseling activities. The fact is that prior to the student's senior year, student-counselor interaction with respect to career preparation and selection was seldom. Generally, the entry of counselors into the process occurred after the students had made career decisions in conjunction with teachers. Yet, colleges, professional schools and science industries, which serve to supplement the student's knowledge of necessary preparation and career opportunities, usually interacted solely with the counselor, not the teacher. Somehow, these disparate forces must be brought together, if a catalyst for the solution of this problem is to be created. It is recommended:

- That science teachers should be formally utilized in the counseling process and the coordination of the efforts of teachers and counselors regarding science activities. All secondary level teachers and administrators should take a basic course in vocational counseling or attend an intensive program in vocational counseling. The latter could be taken in the form of in-service training with minimal graduate credit for staff.

- That teachers should be allowed specified time slots for interacting with students and counselors on career education related to their particular disciplines.

The Science Curriculum

Almost half of the science majors in the college sample entered college with no training in science beyond the second year, or the biology level. This suggests that even college-bound students are not taking full advantage of the high school science curriculum. Although this deficiency does not appear to alter the students' choice of the science major as freshmen, they are beginning college with a limited skill base. This places additional strain on the college for providing backup courses. If these students manage to graduate as science majors, they still fail to be on level with the student who began his preparation with a strong high school background. It is recommended:

- That rather than relaxing science requirements in secondary schools, curricula should be restructured so that students are required to take rigorous foundation courses which will equip them with the technological and problem-solving skills needed in future careers. In addition, changes must be made in the existing curriculum structure to eliminate tracking systems which bar students from advanced science courses or automatically relegate them to lower-level science courses.

- That high school and college administrators can have a greater impact on the kinds of programming which affect students. Efforts need to be made to re-educate this group in much the same way as suggested for counselors and teachers.

Student Attitudes

Both high school and college students sampled had relatively positive attitudes toward science and scientists. This also held true for science and nonscience students alike, suggesting that there was little inherent fear or dislike of science as a field. Neither did possible discrimination in a field heretofore largely comprised of white males appear to dissuade minority students. Certain self/other distinctions seem to be made here, with the degree of interest being the overriding factor.

Students felt that the amount of time and resources spent in preparing for a career in science would not alter their decisions

to pursue science careers. This is substantiated by the number of students willing to pursue careers with long preparation periods. For minorities, the main objection to pursuing a science career appeared not to be problems related to skills, such as mathematics, or negative feelings, but rather an overriding interest in other fields. If this is in fact true, the job of influencing minorities toward science careers is already half completed, since there are few truly negative concerns to overcome other than popularizing a previously unpopular field.

Among the college female science majors, the decision to take science was not necessarily related to the goal of entering a graduate/professional school or pursuing a career, as is the case with male science majors. It appeared that the females took science simply because they enjoyed the discipline. Thus, female science majors tended to overlook the full career opportunities available to them.

Socioeconomic background appeared to impact the students' interest in science. Among the high school group, the students with the strongest science and academic backgrounds had parents in the highest educational and occupational categories. These same students tended to be college-bound and regarded high school science as a requirement for entry into college. It was also found that parents of these students tended to impact their career decisions more so than the school sources used by the nonscience group.

The science group differed from the nonscience group in academic background, motive for taking science, and source of career information and counseling. These were the students who counselors described as being well motivated and having good academic backgrounds. These students were also the targets of major counseling thrusts. Consequently, they were generally more prepared to receive and profit from efforts to channel them into the sciences. However, until there is less disparity between races with regard to socioeconomic status, much time and effort must be expended by the educational system, public and private industry, and the community to make a place for minorities in science. Making this possible cannot be accomplished by simply throwing open heretofore closed doors. Rather, it will be accomplished by a major program to sensitize counselors, teachers and

science employers to the needs and desires of minorities. It cannot be a one-shot effort. A continuing effort must be made to expose minority students to the full spectrum of opportunities available to them through careers in the sciences. It is recommended:

- That sufficient interest must be sparked in students. Counselors and teachers feel that this should start at the grade school level, if the necessary skills are to be mastered by the high school level. Without these skills, the student is only frustrated and any interest which exists will be extinguished. This interest cannot be left to wane during the high school years. Instead, courses should be structured so that they are fun and relevant to the student. Inherent in this restructuring is the abolition of stereotypes common to science, and the need to display models of successful minority scientists which the students can emulate. *This concept has greater ramifications in an integrated setting where science teachers are often white and cannot always provide in themselves the necessary models.*

- That efforts be made to enlarge the base of minority students who will seek careers in science. Present counseling procedures which direct emphasis primarily on those students with high grades in background courses and prior motivation are severely limiting and make no efforts to reach out to other types of students. Counseling efforts must be intensified to this group, if the present pool is to be enlarged and if the cycle is to be broken whereby only select students are encouraged while other students are left largely to their own devices.

- That follow-up activities be introduced to keep students in science activities once the previous steps have been undertaken. It is here that colleges and industry must play a large role. Strong career counseling on the freshman and sophomore levels, in combination with grants and opportunities for cooperative arrangements or work-study with science businesses, can do much to further direct and retain the science student for a science career.

- That attempts be made to educate parents and the community to the need to train more minority scientists and engineers. Practicing scientists have been almost unknown

in the black community, as parents encourage their children to pursue more traditional and "safe" professions. Recent developments in affirmative action processes and the present supply and demand for qualified minorities in science are making these professions viable for blacks.

- That the needs of both "mainstream" and low-income minority students be explored. Too frequently during the past fifteen years, we have overlooked the former student in our efforts to accelerate the achievement of parity for minorities in the low-income bracket.

- That government and military agencies implement intensive efforts for providing scientific and technological training opportunities for minorities employed in their ranks. This would be the beginning of a federal effort aimed at eliminating the underrepresentation of blacks in science and technology.

A Comprehensive Model for Intervention

Science and technology have not been traditional occupational fields for minorities in this country. Unlike some fields where preparation may begin in the latter stages of academic training, preparation for careers in science and technology must begin early with the mastering of specific basic skills. It is often important that training be uninterrupted and continue through the mastery of more advanced skills and the attainment of credentials.

Crucial to this process is the fulfillment of three conditions with respect to student needs: the attainment of fundamental skills (Condition 1); development of a long-range career plan and job availability (Condition 2); and constant reinforcement, motivation and counseling regarding academic and professional requisites (Condition 3). For minorities to reach the ultimate goal of employment in the science fields, these conditions must be met.

Past attempts to provide these conditions for blacks have been haphazard at best. Regional intervention programs have been spotty and have not sought to address a condition characterized by broad and benign neglect. Development of programs

to reverse the patterns of minority participation in the sciences must include strategies which satisfy each of these interlocking conditions.

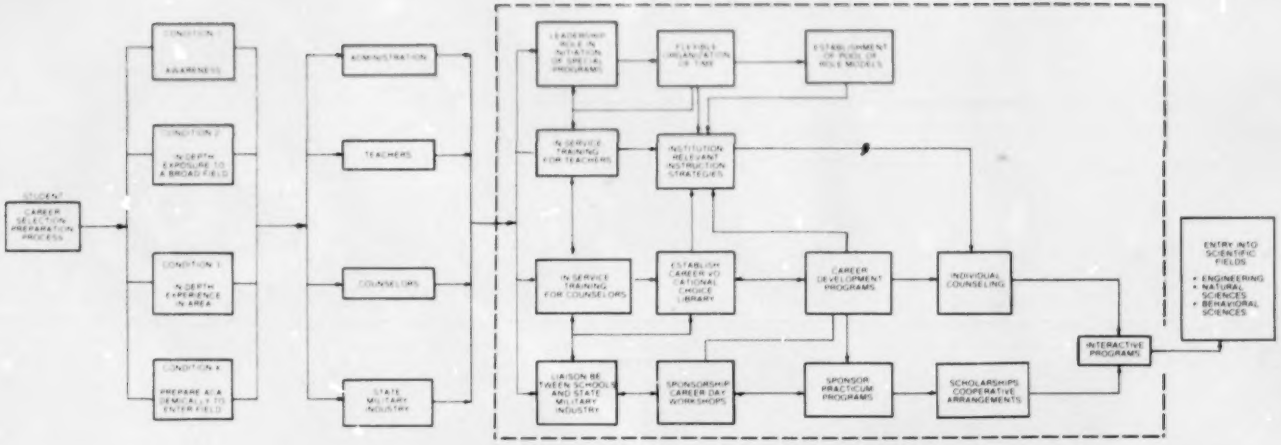
Description of Model. Figure 1 depicts a comprehensive model for corrective action. It is a generic model of career planning which may be applied to numerous disciplines and non-traditional occupations. The model emphasizes the participation and re-education of administrators, teachers counselors, and state, military and industrial agencies and industries. With modification, the model can be applied to the secondary and post-secondary institutional environment.

The model presupposes that the student needs inherent in Condition One are met. It also serves to reinforce student needs on a level concomitant with long-term career goals. Beginning with Condition Two, any intervention tactic must stress non-traditional careers for blacks. If a student has the necessary personal, family and financial supports and is able to obtain the normal academic supports from his present and future educational experience, he may progress through the career selection/preparation process with little difficulty. Without these minimal supports, additional inputs are needed.

The assumptions underlying the model are as follows:

- The majority of black students do not fit the classic mold described above; hence, additional inputs are required.
- Educational administrators, teachers, counselors, industry and government agencies should provide the major inputs for satisfying student needs.
- Each of the above input sources must become aware of present and projected employment needs and areas of under-representation for blacks. It is very important that they begin thinking in terms of non-traditional careers for blacks.
- Each, within his/her own sphere and through interactive methods, must begin corrective action.
- The use of role models is germane to the development of non-traditional career paths for blacks.

Figure 1. INTERVENTIONS



Inherent in the model is the need to alter present responsibilities of teachers, to include more significant participation in the counseling process. Changes are in order so that school support is allotted the time and resources necessary to impact student choices. Also, vocational training of teachers is necessary. Greater involvement of government agencies and industries is needed, not only in providing employment opportunities, but also in educating teachers and counselors and in providing experience and incentives for students. Implicit in any steps taken, however, is a cooperative effort among the essential sources of input.

In order to accelerate the participation of blacks and minorities in the sciences, it is recommended:

Implementation of Model. A number of approaches can be used to achieve the desired results of the intervention model. This section presents some generic recommendations for implementation which can easily be altered to fit the specific situations.

The model does not presuppose a particular intervention point with regard to grade or age level. It is quite possible that some form of intervention can occur at any age level. However, in consideration of the need to shape career tendencies early enough to affect the high school curriculum of a student, it is recommended that Conditions 1 through 3 of the student needs component of the model should be implemented no later than the grade level preceding the one in which the student must decide upon his/her high school curriculum track (i.e., college preparatory, academic, or general/vocational). At that time, students must be made aware of the diverse careers in science. In the first phase, programs similar to existing career days, which have as their primary focus science and technical careers, must be developed. Because science teachers and counselors may be limited in their knowledge of such careers and because the students' perceptions of "scientists" are limited to the extent that some view scientists as peculiar people, a concerted effort must be made to dispel this myth. Science career days can be structured so as to convey a broader knowledge of potential science careers to students, teachers and counselors. Additionally, such career efforts must seek to foster among teacher, counselor, industry, and students the kind of interaction exemplified in the model.

In that one of the major obstacles to the implementation of this model may be the counselors and teachers whose current roles must be restructured, it is recommended that the first effort of implementation must come from an external agent (e.g., minority specialist in science career opportunities). The external agent would be brought in to *assist* the current counselor or teacher in conveying information about science careers. Simultaneously, the external agent would aim to influence the perceptions of teachers and counselors regarding (1) opportunities for minorities in the scientific fields and (2) counseling modalities that are effective for relating to minority students.

The second way to familiarize students with possible science careers during the same time frame or grade level would be to provide opportunities for students to view scientists at work on the job. Once the student has familiarized himself or herself with the various non-traditional or science-related career options, he will be in a better position to select one or two areas of particular interest to explore. Through experiences in both of these phases, the student is then ready to decide the type of curriculum he/she should pursue in high school in order to prepare for entrance into college and for majoring in a specific scientific field.

For the greatest impact to be felt, it is recognized that there is a need for this type of program in places other than the school. Therefore, it is also recommended that personnel at recreation centers, churches, and other community organizations be brought into this process in a systematic way. The in-service training of teachers and counselors, if done concurrently with that of other community persons, will not only provide the necessary background and awareness for the people involved, but will also bring together groups of people who may not have had any common ground of involvement in the past.

An important implication of the proposed intervention model is the need for current and future changes in the training of teachers and counselors. On the university/college level, a broadened approach to the training of educators must be undertaken to equip them with an understanding of the broader role they must play in motivating minority students to enter careers in the sciences.

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OPERATIONAL DEFINITIONS

Certain terms are particularly significant to this study. For this reason, they are defined here as they are used throughout the text.

Term	Definition
Counseling Practices	The criteria (formal or informal) used in recommending students to pursue science careers. Teachers and counselors were asked to indicate those factors they considered important to success in science, and how these influenced their judgements of students' potential. Students were also asked to evaluate counseling practices on the high school and college levels.
Interpersonal Relationships	The frequency and quality of student contact with counselors and teachers in science career activities. This term was used to establish the source of student information about careers, how much confidence is placed in this information, and how useful it is to career choice. Additionally, the term was used to establish the interpersonal role of teachers and counselors as well as the degree to which teachers and counselors confer and cooperate in helping students with career choices.
Non-Traditional Occupation	An occupation which is not perceived by the general population or supported by census data, as typical of occupations held by black men or women. For example, these are occupations in which, traditionally, blacks have not been found or from which they have been systematically excluded. Many of these occupations require advanced college degrees. Occupations such as physicist, psychologist,

OPERATIONAL DEFINITIONS
(Cont'd)

Term	Definition
	engineer, architect, and airline pilot would be exemplary of this term.
Science Employers	Those businesses or organizations involved in the engineering, manufacturing, research, health or related science fields which hire employees in the biological, physical, or natural sciences, as well as those in mathematics and engineering.
Science Oriented Student	High school students who have completed science courses above the general requirements for high school graduation (e.g., biology, chemistry or physics), or college students who have declared majors in any of the sciences, including engineering, the health fields, and mathematics.
Traditional Occupation	This expression is used to indicate an occupation which blacks have historically had little difficulty entering. This type of occupation is characterized by professional activities such as teaching, counseling and the ministry. They are also distinguished by the ability of participants to practice them in the black community more readily than in the white community.
Predominantly Black	High schools in which the racial composition of the student body exceeded 50% black student enrollment. The term applies solely to student enrollment and does not pertain to racial composition of the staff.
Non-predominantly Black	High schools in which the racial composition of the student body exceeded 50% White student enrollment. The term does not apply to racial composition of the staff.